

Before the
Federal Communications Commission
Washington DC 20554

In the Matter of)

)
Amendment of Part 15 of the Commission's)
Rules for Unlicensed Operations in the)
Television Bands, Repurposed 600 MHz Band,)
600 MHz Guard Bands and Duplex Gap, and)
Channel 37, and)

Docket No. 14-165

)
Amendment of Part 74 of the Commission's)
Rules for Low Power Auxiliary Stations in the)
Repurposed 600 MHz Band and 600 MHz)
Duplex Gap)

Docket No. 12-268

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)
Expanding the Economic and Innovative)
Opportunities of Spectrum Through Incentive)
Auctions)

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Federal Communications Commission
Office of the Secretary

REPLY COMMENTS OF
SENNHEISER ELECTRONIC CORPORATION

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SUMMARY

This proceeding requires the Commission to balance the interests of many industries and user groups: broadcast, wireless microphones, wireless broadband, medical telemetry, radio astronomy and public safety. No one industry should prevail. The Commission's recent actions have gone too far in allocating spectrum for broadband use at the expense of wireless microphones. Given that wireless microphones require UHF frequencies for critical uses but broadband does not, it best serves the public interest to reverse this course and provide for two clean blocks of UHF spectrum for wireless microphone use, free of white space devices ("WSDs"). Optimally, the Commission should not eliminate the reserve channels presently set aside for wireless microphone use; barring that, the Commission should allow wireless microphones to operate on the one assigned television channel and on Channel 37, or on any other two clean (low noise and out-of-band emissions from adjacent services) UHF blocks of spectrum, without sharing with WSDs.

Numerous technical studies have been submitted in this proceeding. Many do not stand up to close scrutiny. Using proper assumptions, analyses show that wireless microphones, even operating at maximum allowable power (250 mW), will not interfere with 600 MHz licensees, though they cannot be used for hyper-critical productions when operating co-channel with WSDs.

Based on the record in this proceeding, the Commission should:

- Retain the proposed buffer between the wireless downlink and the 4 MHz portion of the duplex gap set aside for licensed wireless microphone use, but reduce it to 100 kHz to account for the protection afforded by the ETSI emission masks used by wireless microphones;
- Allow unlicensed wireless microphones to operate in the duplex gap and guard bands at 50 mW power to provide for adequate functionality and account for the protection afforded by the ETSI emission masks met by wireless microphones;

- Bar portable WSDs from Channels 14-20 to provide for additional interference-free UHF channels for wireless microphone use;
- Promote effective spectrum sharing between wireless microphones and WSDs by not relaxing adjacent channel emission limits, not raising the power levels for portable WSDs to 100 mW, and not allowing alternative masks that would relax out-of-band-emissions;
- Increase the WSD recheck interval as proposed;
- Expand the geographic protection zone for wireless microphones registered for WSD protection if the location accuracy requirements for WSDs is reduced;
- Adopt a definition of rural that is based on population density, not television channel occupancy, and not increase antenna height (already 30 meters above ground level) for fixed WSDs operating in rural areas so that the utility of this spectrum for wireless microphone use is retained;
- Not impose a database control requirement, or fees, on wireless microphones (which have their own methods of finding clear spectrum) and not allow wireless microphones to be removed from a white space database after 90 days of inactivity;
- Retain white space database registration protection for unlicensed wireless microphones; and
- Ensure that wireless microphones can maximize use of the 600 MHz frequencies during the transition period to allow sufficient time for the allocation of replacement spectrum, the design of new product that complies with the new regulatory regime, and to minimize the hardship faced by wireless microphone owners with 600 MHz equipment. And, require a 60-day notification from licensees prior to entering service.

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**REPLY COMMENTS OF
SENNHEISER ELECTRONIC CORPORATION**

Sennheiser Electronic Corporation ("Sennheiser") hereby replies to comments filed in the above-captioned Federal Communications Commission ("FCC" or "Commission") Notice of Proposed Rulemaking ("NPRM").¹

DISCUSSION

The Commission's proposals are inequitable, "would repeal many protections recently put in place" to protect wireless microphones,² and leave wireless microphone users with

¹ *Amendment of Part 15 of the Commission's Rules for Unlicensed Operations in the Television Bands, Repurposed 600 MHz Band, 60 MHz Guard Bands and Duplex Gap, and Channel 37, and Amendment of Part 74 of the Commission's Rules for Low Power Auxiliary Stations in the Repurposed 600 MHz Band and 60 MHz Duplex Gap; In the Matter of Promoting Spectrum Access for Wireless Microphone Operations; Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Notice of Proposed Rulemaking, Docket Nos. 14-165 and 12-268 (rel. Sept. 30, 2014) ("NPRM").

² Comments of Shure at 8.

insufficient spectrum resources. The Commission should reverse course and provide sufficient spectrum for wireless microphone users while carefully considering proposals that would expand WSD use of UHF at the expense of wireless microphone operations.

A. Wireless Microphone Spectrum Requirements.

Wireless microphones require clear, reliable, reserve channels in UHF spectrum; sharing all spectrum with white space devices (“WSDs”) will undermine the utility of UHF spectrum for wireless microphone operations. Audio-Technica sums up: “the rules as proposed unduly favor WSD operations at the expense of wireless microphones and, if adopted as proposed, will significantly degrade the ability of both licensed and unlicensed wireless microphones to find sufficient interference free spectrum to meet the increasing demand for the production and performance of new content.”³

1. Wireless Microphones Require Two Clean Blocks of UHF Spectrum.

The Commission’s decision to eliminate the two reserved channels in UHF for wireless microphone use greatly impacts the wireless microphone community. Sennheiser agrees that this decision goes far beyond what is necessary to meet the requirements of the Spectrum Act.⁴ The wireless microphone industry concurs that wireless microphones require highly reliable, clean UHF spectrum.⁵ This is important not just for electronic newsgathering (“ENG”) but also for content production, professional performances, and political and sporting

³ Comments of Audio-Technica at 7.

⁴ See Comments of Shure at i and 25.

⁵ Comments of Sennheiser at 5 and 7; Comments of Shure at 7; Comments of CP Communications at 2.

events. As Audio-Technica explains:

From the perspective of the wireless microphone industry (including both equipment manufacturers and content creators) one of the most important steps taken by the Commission in [the 2010 Incentive Auction] proceeding was to recognize that the database solution alone was not sufficient to protect wireless microphones in all cases and that further actions were necessary to ensure that a minimum amount of spectrum would continue to be available as a safe harbor for wireless microphones free from interference from unlicensed WSDs.⁶

Given the sensitivity of wireless microphone receivers, and the systems' fault intolerance and real-time operation requirements, the Commission established two reserved channels on a nationwide basis.⁷

The needs of the wireless microphone industry have not changed since then, and in fact demand has grown. The solution that the Commission proposes, use of the guard bands and duplex gap, is insufficient to support critical wireless microphone operations, given the limited available spectrum and high noise levels in these frequencies. LTE devices without adequate filters will send uncontrolled spectrum emissions into adjacent frequencies,⁸ while co-channel operations with WSDs will interfere with and limit the ability to find clear, clean channels.

Some parties contend that there is adequate spectrum for wireless microphones because wireless microphones do not use the UHF spectrum currently available.⁹ This is incorrect. The reserved UHF wireless microphone channels are heavily used every day throughout the country. During major events, every single available channel is used. Sennheiser has attached a list of

⁶ Comments of Audio-Technica at 4.

⁷ See e.g., *id.*

⁸ See e.g., Attachment to Sennheiser Comments, at 3.

⁹ See Comments of Microsoft at 30 (claiming that there are plenty of 600 MHz frequencies available for wireless microphones); Comments of Google at 37.

frequencies used during the recent NBA All-Star game, which demonstrates the needs of the industry.¹⁰

Google and Microsoft specifically assert that wireless microphones need only be assigned specific channels for “breaking news” events.¹¹ This narrow view ignores the needs of other important wireless microphone users that require hyper-critical links for when there is no “second chance,” such as film production, professional concerts and theater, and historic political and civic events.¹² Other parties claim that the Commission will provide sufficient spectrum for wireless microphones with new spectrum allocations.¹³ None of the bands that the Commission has proposed for wireless microphone use will serve as an adequate substitute for the loss of reserve UHF spectrum.¹⁴

Should the reserved UHF wireless microphone channels no longer be available, the Commission should assign the one “naturally occurring” UHF television channel solely for wireless microphone use. Additionally, Sennheiser has proposed that licensed wireless microphones operators be allowed to operate on a secondary basis to WMTS and RAS on Channel 37, subject to appropriate geographic separation requirements.

Licensed wireless microphones will co-exist better with WMTS than WSDs. Mobile WSDs will be consumer devices, meaning they will be much more likely taken into a medical

¹⁰ Attachment A.

¹¹ Comments of Google at 2, 3, and 36; Comments of Microsoft at 10.

¹² See Comments of Sennheiser at 5.

¹³ See Comments of CTIA at 41 (suggesting that 3.5 and 5 GHz would be appropriate for wireless microphone operations).

¹⁴ *Promoting Spectrum Access for Wireless Microphone Operations; Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Comments of Sennheiser, WT Docket Nos. 14-166 and 12-268, at 20 (filed Feb. 4, 2015) (“Sennheiser Opportunities Comments”).

center where WMTS operations occur. Successful co-existence would then depend upon the proper operation of both the WSD and database itself, something unproven given the lack of any certified portable WSDs.¹⁵ In sharp contrast, licensed wireless microphone operators only operate on spectrum that they determine to be clear of any other transmissions.¹⁶

Sennheiser recognizes the National Academy of Science's ("NAS") concerns regarding the potential impact on radio astronomy from any new Channel 37 entrant.¹⁷ NAS opposes the operation of unlicensed wireless microphones on Channel 37,¹⁸ and Sennheiser agrees that unlicensed wireless microphone use of Channel 37 would not be appropriate. Sennheiser has proposed that Part 74 licensed wireless microphone operators use Channel 37, on a secondary basis and with appropriate geographic separation requirements.¹⁹ Sennheiser has asked NAS for input as to how this proposal can best be managed.

Similarly, Sennheiser recognizes the WMTS Coalition's objection to unlicensed wireless microphone operations on Channel 37,²⁰ and agrees that unlicensed uses would not be appropriate. Licensed use would, however. While some wireless microphones are itinerant, this is different from being mobile; the majority of licensed wireless microphone operations occur at predictable locations, such as TV and film production studios, theaters, and arenas. These are not consumer devices that are taken everywhere in an unpredictable fashion.

¹⁵ See Comments of NAB at 7 ("The Commission presently has no experience with consumers using personal/portable devices as no such devices have yet been approved for public use.").

¹⁶ Comments of Sennheiser at 10.

¹⁷ Comments of the National Academy of Sciences Committee on Radio Frequency at 10.

¹⁸ *Id.*

¹⁹ Comments of Sennheiser at 9.

²⁰ Comments of the WMTS Coalition at n. 47.

The National Association of Broadcasters (“NAB”) proposes that the Commission allocate the entire duplex gap for wireless microphone use.²¹ While Sennheiser agrees with NAB’s premise that wireless microphones require additional and consistent spectrum, even with guard bands the duplex gap will be too noisy to allow for hyper-critical wireless microphone operations. While dedicating the entire duplex gap to wireless microphone use will provide some much-needed UHF spectrum free from WSDs, this is not a sufficient substitute for the reserved spectrum.

2. Wireless Microphones Require Use of the Duplex Gap and Guard Bands.

Given the serious reduction in available spectrum for wireless microphone use in UHF, wireless microphones must be able to maximize operations on the duplex gap and guard bands. Microsoft supports limiting use of the 4 MHz licensed wireless microphone band to electronic newsgathering (“ENG”).²² There is no justifiable reason for limiting the type of licensed wireless microphone operations. Many other critical uses must occur on UHF spectrum.

Microsoft’s asserts that wireless microphones must employ digital modulation in the duplex gap.²³ Whether a wireless microphone employs digital or analog modulation is irrelevant to spectrum efficiency.²⁴ Shure details the error in Microsoft’s logic:

Efficiency gains are only achievable under very consistent conditions and require clean, stable UHF spectrum. Wireless microphone operations relegated to shared spectrum through changes in the white space rules will not be able to take full advantage of the newer technologies that delivery greater microphone efficiency.²⁵

²¹ Comments of NAB at 14-15.

²² Comments of Microsoft at 9.

²³ Comments of Microsoft at 9.

²⁴ See Sennheiser Opportunities Comments at 7-11. In fact, within 1 MHz, the analog ETSI mask is actually tighter than the digital ETSI mask.

²⁵ Comments of Shure at 7.

As Sennheiser and other detail in the wireless microphone opportunities proceeding, uncompressed digital modulation is no more efficient than analog.²⁶

NAS objects to the operation of unlicensed wireless microphones on the Channel 37 guard bands.²⁷ This fear is unfounded because wireless microphones have been operating adjacent to Channel 37 for years without incident. It appears that NAS' concerns stem from an incorrect assumption that wireless microphones operate similar to WSDs, and therefore should access a database before operating on the guard bands.²⁸ Professional wireless microphone operators require clear spectrum and will always check a database, perform a scan, or do other spectrum analysis prior to operating. This is routine, because wireless microphones have high sensitivity receivers and require real-time, low latency transmissions without interruptions.²⁹

NAS suggests that wireless microphones operating in guard bands adjacent to Channel 37 comply with the same geographic separation requirements as white space devices.³⁰ NAS' conclusion is based on the assumption that wireless microphones operating at 20 mW will produce the same out-of-band emissions as WSDs operating at 40 mW.³¹ This is not the case, especially within 1 MHz. The ETSI emission mask attenuates a signal -80 dBc at 100 kHz and

²⁶ Sennheiser Opportunities Comments at 8.

²⁷ Comments of the National Academy of Sciences Committee on Radio Frequency at 11.

²⁸ *Id.*

²⁹ *See* Comments of Audio-Technica at 4.

³⁰ Comments of the National Academy of Sciences Committee on Radio Frequency at 11.

³¹ *Id.*

175 kHz from outside the allowable wireless microphone bandwidth for analog and digital wireless microphones, respectively.³²

Qualcomm argues that it is unlawful for the FCC to allow licensed use of the guard bands.³³ There is nothing in the Spectrum Act that supports this. The Act states that “[t]he Commission *may* permit the use of such guard bands for unlicensed use.”³⁴ The use of the word “may” does not preclude the allocation of licensed use in these bands. Absent a specific prohibition, the Commission may allocate spectrum consistent with its general authority to regulate spectrum.³⁵ There is no reason for the Commission to “withdraw” its decision to allocate 4 MHz of spectrum for licensed wireless microphone use.

Qualcomm additionally states that the duplex gap and guard bands should not be employed by unlicensed users because “licensed mobile operations will interfere with unlicensed white space devices and wireless microphone operations in the duplex gap and guard bands.”³⁶ While Sennheiser agrees that this spectrum will not be ideal for wireless microphone use, this should not bar any wireless microphone use of these bands.

3. Unlicensed Wireless Microphones Must Employ 50 mW Power in the Guard Bands and Duplex Gap.

The Commission proposed that unlicensed wireless microphones operate at a reduced power of 20 mW in the guard bands and the duplex gap.³⁷ Sennheiser and others oppose this and

³² The ETSI masks are available at http://www.etsi.org/deliver/etsi_tr/102500_102599/102546/01.01.01_60/tr_102546v010101p.pdf

³³ Comments of Qualcomm at 18.

³⁴ Spectrum Act § 6407(c), codified at 47 U.S.C. §1454 (emphasis added).

³⁵ 47 U.S.C. § 301.

³⁶ Comments at Qualcomm at 7.

³⁷ NPRM at ¶ 96.

propose that a 50 mW power level would be appropriate.³⁸ As Shure notes, unlicensed microphones currently are allowed to operate at 50 mW, and the Commission provides no technical justification that a lower power is necessary.³⁹ Audio-Technica details how this rule would “effectively prevent wireless microphones from making use of the guard bands or duplex gap,” as this is not clean spectrum and wireless microphones will be more susceptible to interference than WSDs.⁴⁰ Additionally, creating specific technical rules for wireless microphones operating in such small slivers of spectrum would render product development uneconomical.

It is important to consider that the unlicensed wireless microphones that will operate in the UHF frequencies are not consumer devices and should not be treated as such. In its comments, Sennheiser outlined three classes of wireless microphone users: Class A licensed professional users; Class B other professionals and semi-professional users; and Class C hobbyist users.⁴¹ Wireless microphone manufacturers have transitioned wireless microphones designed for Class C hobbyist users to unlicensed bands. A large portion of unlicensed wireless microphone are used for professional applications, by Class A and Class B users. These should not be considered consumer products. For example, a significant portion of Class B unlicensed operators are required to comply with the Americans with Disabilities Act (“ADA”), which mandates the provision of an assistive listening system for the hearing challenged. In most situations, the only effective way to provide an ADA compliant system is through the use of wireless microphones.

³⁸ Comments of Sennheiser at 15; Comments of CP Communications at 7; Comments of Audio-Technica at 10.

³⁹ Comments of Shure at 19-20.

⁴⁰ Comments of Audio-Technica at 10.

⁴¹ Comments of Sennheiser at 4-5.

4. Wireless Microphones Should Operate on Channels 14-20, but Portable WSDs Should Not.

The Commission proposed that WSDs share with wireless microphones available spectrum on Channels 14-20. This is a prime example of the Commission going beyond what is required by the Spectrum Act by maximizing available UHF spectrum for WSDs at the expense of the effective operations of wireless microphones. The wireless microphone industry opposes sharing Channels 14-20 with portable WSD, as wireless microphone users require a certain amount of interference-free UHF spectrum.⁴² As a practical matter, as Shure explains, the Commission encouraged the development of wireless microphones for these frequencies;⁴³ allowing WSDs to share the same spectrum would render this new equipment less usable.

Motorola suggests that wireless microphones will threaten public safety operations if allowed to operate on Channels 14-20. Motorola offers no technical support for this conclusion, wireless microphones have shared these frequencies for years without impacting PLMS or CMRS service.⁴⁴

B. Co-Existence between Wireless Microphones and Other Users.

There is insufficient real world experience to justify the “aggressive proposals” made in the proceeding with regard to WSD operations.⁴⁵ And a fundamental error in many of filings is the assumption that wireless microphones operate like white space devices, and should meet the same rules. The interference control system that the Commission devised for white space devices allows WSDs to operate when there is an available channel and shut off when there is not (or in the instance when a WSD is unable to contact a database). Wireless microphones are

⁴² Comments of Sennheiser at 10; Comments of Shure at 24.

⁴³ Comments of Shure at 24.

⁴⁴ Comments of Sennheiser at 14.

⁴⁵ Comments of NAB at 2.

fault intolerant and need to operate without interruption; if they are shut off by a database control, a newscast, television coverage of a breaking news event, or a performance is shut off as well.

A number of parties provide technical analyses which, when examined closely, make inaccurate assumptions about wireless microphones that are serious enough to undermine the conclusions. Indeed, many of these parties undermine their conclusions by sweeping WSDs and wireless microphones into the same category, even though the technical characteristics of these devices are quite different. As always, in answering technical questions, the Commission must consider practical, real-world applications and experiences over speculative worst case or extreme scenarios conjured in a lab. When considered in this way, the engineering shows that wireless microphones will not cause harmful interference to wireless handsets or WSDs (or broadcast, notwithstanding the repacking process).

1. Wireless Microphones Will Not Interfere with Wireless Handsets.

Wireless microphones can exist adjacent to 600 MHz operations without causing harmful interference. The Commission set a 1 MHz buffer between the 4 MHz block allocated for licensed wireless microphone use and the 600 MHz downlink block.⁴⁶ The wireless microphone community has shown that a 100 kHz buffer is appropriate.⁴⁷ The ETSI masks are sufficient control for emissions into the wireless bands.⁴⁸

⁴⁶ NPRM at ¶ 95.

⁴⁷ Comments of Sennheiser at 8; Comments of Shure at 16.

⁴⁸ The ETSI masks are available at http://www.etsi.org/deliver/etsi_tr/102500_102599/102546/01.01.01_60/tr_102546v010101p.pdf

The Commission incorrectly assumes that wireless microphones may interfere with operations in the downlink band because they are unable to detect a signal and will assume that a channel is clear.⁴⁹ CP Communications explains that this concern is unwarranted:

Transmissions from a downlink band will be coming from a base station and will have to be strong enough for a handset to use with all the limitations of its receiving ability that are due to antenna size and body absorption. It is not plausible that a sensitive wireless microphone receiver with a relatively efficient antenna would be unable to hear the base station signal if it is strong enough to be usable by a handset.⁵⁰

CP Communications additionally disputes the idea that a group of wireless microphones will have the same interference potential as one 4 W EIRP base station.⁵¹ A group of microphones will have a number of low powered transmitters that are spread out, making it unlikely that the entire group of microphones will be near a handset (as opposed to a fixed WSD with one antenna).⁵²

Broadcom submitted an analyses showing that the LTE downlink will be protected, concluding that “unlicensed devices can coexist with licensees at 3 MHz when operating at 40 mW.”⁵³ While the operation of WSDs and wireless microphones differ greatly and should not be equated, if WSDs can protect LTE operations then there should be no question that wireless microphones will not interfere with LTE. The Dynamic Spectrum Alliance, which seeks to operate in unlicensed spectrum under the IEEE 802.11af Wi-Fi standard, in fact concurs that wireless microphones are compatible with LTE, concluding that “[w]ireless microphone use will

⁴⁹ NPRM at ¶¶ 167-168.

⁵⁰ Comments of CP Communications at 5.

⁵¹ See NPRM at ¶¶ 167-168.

⁵² Comments of CP Communications at 5.

⁵³ Comments at Broadcom at 2.

not compromise LTE operation because the microphone devices operate at very low power in very narrow bandwidths no greater than 200 kHz.”⁵⁴

Several parties still question whether wireless microphones will cause interference to wireless operations. Their technical showings are fundamentally flawed and do not support this contention.

Qualcomm objects to the Commission allowing wireless microphone and WSD operations in the guard bands, “without providing any technical analysis and ignoring a mountain of evidence to the contrary.”⁵⁵ Wireless microphones have operated for decades adjacent to television and land mobile service without a buffer. Qualcomm does not specify what type of wireless microphone was tested, so Sennheiser cannot comment on the validity of all of the assumptions relied upon, but the Commission should consider the following:

- Qualcomm tested for 1 dB of desense to the LTE handsets.⁵⁶ This level is overprotective, allowing large amounts of spectrum to lay fallow; it is highly questionable whether desensing of a single dB will cause blocking failure to any quality built receiver in the vast majority of situations.
- Though Qualcomm stated that it was testing indoor operations, it relied on threshold figures from -15 C° temperature tests rather than the more relevant 25 C° temperature tests,⁵⁷ which varied the measurements for the wireless microphone signals they tested by 2.5 dB in Test 2 and 2.8 dB in Test 4.
- Qualcomm simulated a wireless microphone signal in the duplex gap modeled as a continuous wave (“CW”) tone.⁵⁸ In practical application, audio input to a wireless microphone is never continuous, but rather constantly varying, just like the ambient sounds in the environment.

⁵⁴ Comments of the Dynamic Spectrum Alliance at 8.

⁵⁵ Comments of Qualcomm at iii.

⁵⁶ Comments of Qualcomm at 9.

⁵⁷ Comments of Qualcomm at 10-11 and Table A-1.

⁵⁸ Comments of Qualcomm at 9.

- Qualcomm erroneously used Effective Isotropic Radiating Power (“EIRP”), the power output measurement for WSD, rather than conducted power at the antenna terminal, which is how power levels of wireless microphones is measured.⁵⁹ When antenna gain is zero, EIRP and conducted power are equivalent. Handheld or body pack wireless microphone transmitters require omnidirectional antennas (because the transmitters are in constant motion). An isotropic antenna is omnidirectional with zero gain, but only exists as a theoretical ideal. Therefore, the EIRP of a microphone is lower than the rated conduct power, typically by 2 to 3 dBm. As a result, 50 mW wireless microphones have an EIRP of around 30 mW and 20mW wireless microphones have an EIRP of around 12 mW.
- Qualcomm concludes that a wireless microphone operating 1 MHz away from the downlink block with output power of 13 dBm EIRP (~ 35mW conducted power) “translates to an interference radius of 69 meters (or 226 feet).”⁶⁰ This is wrong. A wireless microphone at that power level can barely operate over that range on its own frequency; the ETSI emission mask attenuates a wireless microphone signal to -90 dB at 1 MHz from the center carrier frequency.
- The Figure 1 graph is not drawn to scale in magnitudes and bandwidths;⁶¹ inferences drawn from it may be incorrect.

CTIA has submitted a similarly faulty analysis to support the contention that the out-of-band emissions (“OOBE”) from wireless microphones (and WSDs) pose a great threat to 600 MHz wireless services. If wireless microphone OOBes are the greatest threat to LTE, then there is no threat:

- CTIA did not conduct actual testing of a wireless microphone, claiming that none were available that met the FCC’s proposed technical parameters.⁶² In fact, one Sennheiser product (EW300IEM-G2) does and although it is now out of production, thousands are in use. One variant that is no longer in use in the U.S. but is readily available outside this country operates in the frequency range used for their guard band tests. Alternately, CTIA could have used a higher power transmitter and detuned the antenna by simply cutting it to reach the desired EIRP, a trivial process for a competent RF engineering firm such as VCOM.

⁵⁹ Comments of Qualcomm at 10-11

⁶⁰ Comments of Qualcomm at 11.

⁶¹ Comments of Qualcomm at 9.

⁶² Comments of CTIA at 8.

- CTIA instead simulated wireless microphones assuming a 0 dB antenna and a continuous tone.⁶³ As stated above, these parameters are not valid assumptions with regard to the operation of wireless microphones, and allow CTIA to draw incorrect conclusions.
- Like Qualcomm, CTIA erroneously used EIRP, the power output measurement standard for WSD, rather than conducted power at the antenna terminal, which is the measurement for wireless microphones.⁶⁴ As noted above, the EIRP of a wireless microphone is lower than the rated conduct power, typically by 2 to 3 dBm; thus, 50 mW wireless microphones will operate at an EIRP of around 30 mW and 20 mW wireless microphones will operate at an EIRP of around 12 mW.
- CTIA also, like Qualcomm, assumed an unreasonable 1 dB threshold for blocking handsets; it would be bad public policy for the Commission to set aside spectrum to provide this much protection.
- CTIA also assumed handheld use,⁶⁵ though body pack wireless microphone transmitters, which are subject to higher body absorption effects, are used far more often.⁶⁶
- CTIA assumed a one meter separation distance between wireless microphones and wireless handsets.⁶⁷ In real-world applications, this is the exception. Wireless microphones are primarily used on-stage, in studios or production sets, and in presentations, where the users are distanced farther than a single meter from audience members who would have handsets. And, it is the norm for audience members to turn off their handsets during performances, presentations, religious services, educational instruction, content production, etc. At large arena and stadium events when handsets are used, the separation distance between the wireless microphones and the public is generally significant.
- CTIA made liberal conclusions, equating barely detectible threshold standards with device failure. One example is the conclusion that a wireless microphone would cause interference if operated within 9 MHz of the lower guard band.⁶⁸ Given the years that wireless microphones have operated immediately adjacent to primary services, either CTIA is assuming mobile devices have no reasonable level of selectivity, which if true it would be poor policy for the FCC to protect, or its conclusion is badly overstated. If a low-power wireless microphone operating within 9 MHz would cause harmful

⁶³ *Id.*

⁶⁴ Comments of CTIA, Appendix B, p.10.

⁶⁵ *Id.*

⁶⁶ Body packs outsell handheld wireless microphones many times over.

⁶⁷ Comments of CTIA at 10.

⁶⁸ Comments of CTIA at 20 and 27 at Figure 7.

interference to a mobile device, Sennheiser questions how that device could function where there is an active TV signal operating at much higher power, which under some repacking plan scenarios would be located only 7 MHz from the lower guard band.

For these reasons, the Commission should disregard the conclusions of Qualcomm and CTIA with regard to the effects on 600 MHz licensees by wireless microphones.

2. White Space Devices Will Impede Wireless Microphone Use of Shared Spectrum.

To foster better spectrum sharing between wireless microphones and WSDs, the Commission proposed to increase the frequency at which WSDs must check a database, to every twenty minutes.⁶⁹ Sennheiser supports this proposal, as it will allow wireless microphones to operate with greater protection on the remaining UHF channels that will be available after the close of the incentive auction.⁷⁰

Google and Microsoft object to this re-check frequency on the basis that it increases the number of database inquiries by 72-fold, increasing operating cost and battery use.⁷¹ Without data on the length of these queries or battery drain, however, the Commission cannot determine whether the proposed recheck frequency would have any detrimental effect on WSDs.

The Wireless Internet Service Providers Association (“WISPA”) objects to any increase in re-check frequency on the basis that it will add difficulty to WSD operations and could disrupt critical public safety operations.⁷² The White Space Alliance disagrees that an increased re-check interval would be difficult for a database to achieve.⁷³ And given that only a small number of grants for equipment certification have been issued for WSD devices, it is difficult to

⁶⁹ NPRM at ¶¶ 192-193.

⁷⁰ Comments of Sennheiser at 11.

⁷¹ Comments of Google at 47.

⁷² Comments of WISPA at 18-20.

⁷³ Comments of the White Space Alliance at 25.

understand how this change would disrupt the fixed wireless white space broadband ecosystem.⁷⁴ As for critical operations, the Commission has ensured that there is sufficient spectrum for public safety use, and indeed has brought in sufficient funds through auction to build a public safety broadband network.

The Commission additionally proposed relaxing the separation distance requirements for portable WSDs.⁷⁵ Sennheiser expressed concern that if this were implemented, registered wireless microphones may be subject to interference unless the geographic protection zones were expanded. Shure agrees that the protection zone must be increased proportionately to the decrease in geographic accuracy.⁷⁶

Microsoft proposes that the Commission increase allowable power levels for portable WSDs to 100 mW.⁷⁷ Sennheiser opposes any increase in power for WSDs, as that would be counter to the Commission's goals of providing for effective spectrum sharing between wireless microphones and WSDs. For example, the Commission looks at aggregate power for wireless microphones in operating in the same channel, but does not require this for WSDs.

Similarly, Sennheiser opposes Motorola's request that the Commission allow for a "relaxed transmit mask," or any other type of mask for WSDs that would result in an increase in out-of-band emissions.⁷⁸

The Commission proposed loosening certain rules for WSDs in "rural" areas, basing the definition of rural on the number of unused television channels rather than population density.⁷⁹

⁷⁴ Comments of WISPA at 19.

⁷⁵ NPRM at ¶ 76.

⁷⁶ Comments of Shure at 28.

⁷⁷ Comments of Microsoft at 3-5 and 14-15.

⁷⁸ Comments of Motorola at 6-7.

Sennheiser objected to this definition of rural, and to increasing allowable antenna height for WSDs in rural areas, which already is 30 meters above ground level; higher antenna height will spread WSD emissions, potentially interfering with the many wireless microphone operations that do occur in less populated areas.⁸⁰

Others agree. Shure explains that the increase in antenna height would substantially increase the transmission range of fixed WSDs, and notes that no analysis has been performed to determine the impact on wireless microphones.⁸¹ Audio-Technica states that, while this proposal may reduce WSD base station deployment costs, the FCC does not achieve spectrum efficiency goals when “higher powered operations would preclude other service providers from sharing that same spectrum.”⁸² Database administrator Spectrum Bridge states that the Commission’s definition of rural is too variable, and supports instead the definition of rural proposed for 3.5 GHz.⁸³ Sennheiser would support this approach, as that definition is tied to population density and facilitate good WSD database management.

WISPA believes that wireless microphones do not require protection in rural areas.⁸⁴ Wireless microphones are used routinely in rural areas, not just for spontaneous newsgathering.

⁷⁹ NPRM at ¶¶ 44-53.

⁸⁰ Comments of Sennheiser at 11.

⁸¹ Comments of Shure at 28; *see also* Comments of Audio-Technica at 15 (“If unlicensed wireless microphone power levels must be set at the same levels as WSDs (and in some cases substantially lower) to avoid interference, it follows that increasing WSD power and antenna heights in rural areas to the higher levels proposed will create new interference with proximate wireless microphones and undermine the Commission’s policy of spectrum sharing.”).

⁸² Comments of Audio-Technica at 15.

⁸³ Comments of Spectrum Bridge, Inc. at 4.

⁸⁴ Comments of WISPA at 23.

For example, as Sennheiser explained, wireless microphones used at many sporting and public events would be affected.⁸⁵

CEA suggests that wireless microphones may cause interference to WSDs when operating in the duplex gap and guard band.⁸⁶ While CEA suggests that the FCC failed to conduct an adequate technical analysis, CEA does not provide support for its concern.

3. Wireless Microphones Will Not Interfere with Broadcast Services When Operating Co-Channel, and Should be Allowed to Meet a Threshold Field Strength Test.

CEA expresses concern that unlicensed wireless microphones could interfere with television stations “if the technical requirements are loosened too much.”⁸⁷ CEA’s fears are unfounded.

CEA overstates the rule change, claiming it “represents a significant reduction from the Commission’s previously proposed distances, which ranged from 97 to 129 kilometers.”⁸⁸ This statement gives the false impression that the separation distance has been radically reduced from 97 km (at minimum) to 4 km, but CEA is comparing entirely different measurements: the distance from the broadcast antenna (97 km) vs. the distance from the outside service contour (4 km).

In any event, the 4 km separation distance for wireless microphones is overly conservative, as it was established for WSDs operating with an EIRP of 4000 mW with an antenna at 3 meter height above average terrain (“HAAT”). The Commission reasoned that sixteen 250 mW licensed wireless microphones operating within the same 6 MHz TV channel

⁸⁵ Comments of Sennheiser at 11.

⁸⁶ Comments of CEA at 6-7.

⁸⁷ Comments of CEA at 3.

⁸⁸ *Id.*

cumulatively equaled 4000 mW.⁸⁹ The cumulative power from sixteen separate sources spaced apart is not the same as to a single source. It would be an extremely rare occasion that sixteen 250 mW power wireless microphones would be operated within the same TV channel; Sennheiser has no knowledge of this ever occurring.⁹⁰ Furthermore, the 3 meter antenna HAAT is not applicable to wireless microphones. The only standard 250 mW wireless microphone transmitters available on the market are body packs, in which the antennas typically sit at waist level, certainly not 3 meters HAAT. These body packs are subject to body absorption effects far more than handheld devices.

For these reasons, Sennheiser has proposed that wireless microphones operating co-channel should instead meet a field strength threshold of -80 dBm at operation site.⁹¹ Virtually all Part 74 wireless microphones on the market now have a SCAN function that finds clear frequencies below this threshold.

CEA additionally errs in assuming that sixteen wireless microphones operating at 20 mW will produce 320 mW aggregate power within a channel.⁹² Once again, this overly simplistic theoretical calculation does not yield a realistic result. CEA assumed that, "[a]ny positive gain on wireless microphones' transmitting antennas will cause the radiated power to be greater than the proposed 20 mW, increasing the concern about harmful interference."⁹³ This fear is

⁸⁹ That is, $16 \times 250 \text{ mW} = 4000 \text{ mW}$.

⁹⁰ Wireless microphones would only operate at 250 mW by a licensed operator and at unique occasions such as a golf tournament broadcasts where that power level is required to achieve range, though in such an instance the microphones would be employed at considerable geographic distance from each other. Operation of unlicensed wireless microphones, which is limited to 50 mW, would almost always occur indoors, where attenuation of RF signals is significant.

⁹¹ Comments of Sennheiser at 13.

⁹² Comments of CEA at 5.

⁹³ Comments of CEA at n.14.

unfounded, as portable transmitters have omnidirectional antennas with some level of negative gain.

4. A Database Control Requirement Will Impede Use of Spectrum by Wireless Microphones.

The Commission sought comment on whether the Spectrum Act requires that unlicensed wireless microphones access a white space database.⁹⁴ Sennheiser and other wireless microphone manufactures demonstrate that wireless microphones meet the requirements of the Act by relying on sensing and/or manual database checks to find clear spectrum.⁹⁵

A database control requirement would impose further hardship and disruption on the wireless microphone industry in addition to what is being created by the drastic reduction in spectrum. As Shure explains, white space database control would require the redesign of basic microphone architecture, increasing both costs to consumers and time to market for compliant devices.⁹⁶ Audio-Technica states: “[u]nlike WSDs, the ability to access the Internet and to query databases is not an inherent part of the design or function of wireless microphones.” A database requirement would “degrade performance due to the limitations on current battery technology” and “render all current product in the market obsolete,” which will impose additional costs on owners.⁹⁷ Given that there is insufficient real world experience to justify reliance on the

⁹⁴ NPRM at ¶¶ 162-164.

⁹⁵ Comments of Sennheiser at 16; Comments of Shure at 40. This is not dissimilar to a WSD installer manually inputting the location of a fixed WSD into a white space database. See 47 C.F.R. § 15.711(b)(1).

⁹⁶ Comments of Shure at 18.

⁹⁷ Comments of Audio-Technica at 12.